CLAIMS

1. An infra-red imaging camera comprising:
an uncooled and unshielded detector arranged to detect infra red radiated energy, and
a calibrator to carry out periodic calibration operations by taking at least one calibration temperature measurement over said camera and to derive from said at least one calibration temperature measurement a reference temperature indicative of radiated energy not from an external scene, said reference temperature being usable to correct energy detected at said uncooled sensor to discount radiated energy not from an external scene, thereby to enable energy at said detector to be translated into a temperature of objects in said camera's field of view.

2. The infra-red imaging camera of claim 1, configured to use said reference temperature derived from said calibration temperature measurement to correct temperature measurements of said infra-red energy gathered from said external scene.

3. The infra-red imaging camera of claim 2, configured to combine a value from an initial calibration temperature measurement with a second value taken from a second calibration temperature measurement, said combining using a time-dependent function, to produce extrapolations of said corrections for later points in time after said calibration temperature measurements.

4. The infra-red imaging camera of claim 3, wherein said time-dependent function comprises a mathematical extrapolation function from most recent calibration temperature measurements.

5. The infra-red imaging camera of claim 1, configured to make said correction using an initial value which is a function of a temperature measurement of a shutter of said camera.

6. The infra-red imaging camera of claim 1, configured to make said correction using an initial value which is a function of a temperature measurement of a housing of said camera.

7. The infra-red imaging camera of claim 1, having a camera thermal time constant of a first duration, and wherein said calibrator is configured to make a plurality of said calibration temperature measurements during said first duration.

8. The infra-red imaging camera of claim 7, wherein said plurality is ten or less.

9. The infra-red imaging camera of claim 1, wherein a first thermistor is located on a shutter of said camera, a second thermistor is located on an external surface of detector's vacuum packaging of said camera and a third thermistor is located on a casing surrounding optics of said camera, and wherein said calibration temperature measurement comprises taking readings from each of said thermistors.

10. The infra-red imaging camera of claim 5, wherein said shutter comprises a sheet.

11. The infra-red imaging camera of claim 5, wherein said shutter comprises a sheet having an emissivity substantially approaching 1, within a spectral frequency range used by said detector.

12. The infra-red imaging camera of claim 11, wherein said uncooled detector is configured to make said calibration temperature measurement by measuring radiation from said shutter.

13. The infra-red imaging camera of claim 5, wherein said shutter comprises a sheet having a reflectivity substantially approaching 1, within a spectral frequency range used by said detector.

14. The infra-red imaging camera of claim 13, wherein said uncooled detector is configured to make said calibration temperature measurement by measuring radiation reflected from said shutter, said radiation being indicative of a temperature of said uncooled detector.

15. The infra-red imaging camera of claim 5, wherein said shutter is mounted such as to have a first stable mechanical position obscuring focusing optics of said camera and a second stable mechanical position allowing free line of sight between said focusing optics and said detector.

16. The infra-red imaging camera of claim 1, wherein said uncooled detector comprises a microbolometer array.

17. The infra-red imaging camera of claim 11, wherein said detector is configured to obtain calibration temperature measurements from a video signal of an internal reference unit.

18. The infra-red imaging camera of claim 1, wherein temperature measurements at said uncooled detector from said infra-red energy of said external scene are subject to an error introduced by a modulation transfer function of said camera for high spatial frequencies, said infra-red

imaging camera being equipped to overcome said error by incorporating an inverse of the modulation transfer function thereof.

19. The infra-red detector of claim 5, operable to make said calibration temperature measurement at an interval of time less than the camera thermal time constant.

20. The infra-red imaging camera of claim 1, wherein said detector comprises a microbolometer array, said camera being further configured to obtain said calibration temperature measurement at a same time as obtaining a non-uniformity correction matrix for said array.

21. The infra-red imaging camera of claim 20, configured to use a same signal to temperature function for all pixels of said array.

22. The infra-red imaging camera of claim 20, wherein a shutter of said camera is configured for use for measurements to enable bad pixel replacement of said array.

23. Temperature correction apparatus, for correcting a response of a radiometer in accordance with a local camera temperature, said radiometer comprising:
an unshielded uncooled infra-red (IR) sensor, for providing an image response in order to form a temperature image in accordance with IR radiation impinging on said IR sensor's field of view (FOV), and
a shutter, for controllably obscuring said FOV, an internal face of said shutter forming a measurement surface for an internal temperature reference unit;
said temperature correction apparatus comprising:
a temperature sensor for determining a local camera temperature using said measurement surface,

a referencer, for deriving from said local camera temperature a reference temperature indicative of radiated energy not from an external scene and for using a response of said IR sensor to said local camera temperature to approximate a temporal effect of temperature drift of said local temperature; and

a signal corrector associated with said temperature sensor and said referencer, said signal corrector being configured to discount impinging IR radiation not from an external source by producing a correction to said image in accordance with said approximated temporal effect and said reference temperature.

24. Temperature correction apparatus according to claim 23, wherein said reference temperature and said response of said IR sensor to said local camera reference temperature are determined during the obscuration of said FOV by said shutter.

25. Temperature correction apparatus according to claim 23, wherein said IR sensor comprises a microbolometer.

26. Temperature correction apparatus according to claim 23, wherein said IR sensor comprises an array of microbolometers.

27. Temperature correction apparatus according to claim 23, wherein said approximation is a mathematical functional approximation based on previous measured data.

28. Temperature correction apparatus according to claim 27, wherein said approximation is an extrapolation of two or more successive temperature measurements.

29. Temperature correction apparatus according to claim 26, wherein said IR sensor array is operable to provide a two-dimensional image.

30. Temperature correction apparatus according to claim 23, wherein said signal corrector is further operable to perform non-uniformity correction (NUC) using said measurement surface.

31. Temperature correction apparatus according to claim 30, further comprising an array having a plurality of pixels, said array being configured to use a same signal to temperature function at each pixel of said array to obtain temperatures.

32. Temperature correction apparatus according to claim 23, wherein said signal corrector is further operable to perform bad pixel replacement (BPR) using said measurement surface.

33. Temperature correction apparatus according to claim 23, wherein said measurement surface is substantially a black body for an IR spectral frequency range of interest.

34. Temperature correction apparatus according to claim 33, wherein said temperature sensor is configured in relation to said measurement surface to measure a temperature thereof.

35. Temperature correction apparatus according to claim 33, wherein said temperature sensor is operable to measure the radiation emitted by said measurement surface.

36. Temperature correction apparatus according to claim 23, wherein said measurement surface is substantially a reflective surface for an IR frequency range of interest.

37. Temperature correction apparatus according to claim 36, wherein said temperature sensor is configured in relation to said measurement surface to measure a temperature thereof, said temperature being a temperature of said apparatus.

38. Temperature correction apparatus according to claim 29, wherein said signal corrector is operable to calculate a difference between a microbolometer level and a reference level comprising an average video signal of said IR sensor, and to use said difference to produce said correction.

39. A temperature corrector according to claim 38, configured to produce said corrected image using numerical processing.

40. A temperature corrector according to claim 23, further comprising a shutter controller for controlling a position of said shutter between an obscuring position and an exposing position.

41. Temperature correction apparatus according to claim 23, further comprising a filter for removing or compensating camera modulation transfer (MTF) effects from said corrected image.

42. A method for correcting a response of a radiometer in accordance with a local temperature, said radiometer comprising an infra-red (IR) sensor, for providing an image response in order to form a temperature image in accordance with IR radiation impinging on said IR sensor's field of view (FOV), and a shutter, for controllably obscuring said FOV, said method comprising:

determining, while said FOV is obscured by said shutter, a local camera temperature of a location selected in accordance with an emissivity of said shutter;
deriving from said local camera temperature a reference temperature reflecting impinging IR radiation not from an external source; and
producing a correction to said image in accordance with said reference temperature.

43. A method according to claim 42, further comprising determining a time dependent response of said radiation sensor to said local camera temperature; and using said reference response in modifying said correction in between determinations of said reference temperature.

44. A method for correcting a response of a radiometer according to claim 42, wherein said IR sensor comprises a microbolometer array.

45. A method for correcting a response of a radiometer according to claim 44, further comprising performing non-uniformity correction (NUC).

46. A method for correcting a response of a radiometer according to claim 45, comprising using a same signal to temperature function at each pixel of said array to obtain a temperature.

47. A method for correcting a response of a radiometer according to claim 44, further comprising performing bad pixel replacement (BPR).

48. A method for correcting a response of a radiometer according to claim 42, wherein said shutter comprises an internal surface which is substantially a blackbody at an IR spectral frequency range of interest, and said

determining of said local camera temperature comprises measuring a temperature of said surface.

49. A method for correcting a response of a radiometer according to claim 42, wherein said shutter comprises an internal surface which is substantially fully reflective at an IR spectral frequency range of interest, and said determining of said local camera temperature comprises measuring a temperature at said surface, said temperature being representative of said IR sensor.

50. A method for correcting a response of a radiometer according to claim 42, further comprising filtering said corrected image response to compensate camera MTF effects.

51. An infra-red camera comprising:
focusing optics for gathering infra-red energy from an external scene,
an unshielded infra-red sensor arranged to detect said infra red radiated energy from said focusing optics,
a high pass filter, wherein temperature measurements at said infra-red sensor from said infra-red energy of said external scene are subject to an error introduced by a camera modulation transfer function for high spatial frequencies, said high pass filter being configured to overcome said error by incorporating an inverse of the modulation transfer function of the camera, and
a calibrator to carry out periodic calibration operations by taking at least one calibration temperature measurement over said camera and to derive from said at least one calibration temperature measurement a reference temperature indicative of radiated energy not from an external scene, said reference temperature being usable to correct energy detected at said uncooled sensor to discount radiated energy not from an external scene, thereby to enable energy

at said detector to be translated into a temperature of objects in said camera's field of view.

52. The infra-red detector of claim 51, wherein said infra-red sensor is an uncooled infra-red sensor.

53. The infra-red detector of claim 51, wherein said infra-red sensor is an uncooled microbolometer array.

54. A method of upgrading an infra-red imaging camera for making temperature measurements, the existing infra-red camera comprising:

focusing optics for gathering infra-red energy from an external scene,

an uncooled detector unshielded from internal parts of said camera and arranged to detect infra red radiated energy, and

a shutter, controllably mounted to periodically interpose itself between said focusing optics and said uncooled sensor array to allow said detector to carry out periodic uniformity correction operations from temperature measurements over said shutter surface,

the upgrade comprising applying at least one temperature sensor within said camera for allowing a localized temperature measurement to be taken at periodic intervals for use in deriving a reference temperature indicative of radiated energy not from an external scene, for the correction of a received image.

55. The method of claim 54, wherein applying said at least one temperature sensor comprises fixing a temperature sensor to said shutter.

56. The method of claim 54, wherein applying said at least one temperature sensor comprises fixing a first temperature

sensor to said shutter, and an additional sensor to a detector housing of said camera.

57. The method of claim 54, wherein said applying said at least one temperature sensor comprises configuring said at least one sensor to measure said local temperature when said shutter interposes between said focusing optics and said sensor.

58. The method of claim 54, wherein temperature measurements at said infra-red detector from said infra-red energy of said external scene are subject to an error introduced by a camera modulation transfer function for high spatial frequencies, said upgrade further comprising providing a high pass filter in association with said camera, said high pass filter being configured to overcome said error by incorporating an inverse of said camera modulation transfer function.

59. The method of claim 58, wherein said high pass filter is any one of a group comprising hardware, firmware, software, or a combination thereof.

60. The method of claim 58, comprising arranging said high pass filter to compensate an error introduced by the signal processing performed by said infra-red imaging camera.

61. The infra-red imaging camera of claim 2, wherein said camera is further configured to perform said correcting using at least one radiation measurement of said shutter performed simultaneously with said at least one calibration temperature measurement.